

**Ministry of Transportation  
Materials Engineering and Research Report**



**2007 Pavement Condition  
Rating (PCR) Workshop**

**MERO-029**

Publication  
Title

# 2007 Pavement Condition Rating (PCR) Workshop

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<b>Abstract</b>	<p>Pavement Condition Index (PCI) is a quantitative assessment of pavement performance. The PCI comprises two components:</p> <ul style="list-style-type: none"> <li>1) Ride Condition Index (RCI)</li> <li>2) Distress Manifestation Index (DMI)</li> </ul> <p>The RCI is based on objective measurements of pavement roughness derived from mechanical devices. The DMI is obtained by visually evaluating pavement according to standard procedures taking into account the type, severity and extent of observed distresses. The visual evaluation method is prone to personal bias and lack of consistency and repeatability, because of its subjective nature. To improve the effectiveness of PCI as an indicator of pavement condition and as a tool for planning pavement maintenance and rehabilitation strategies, it is imperative that errors resulting from subjective assessment of the DMI be minimized. To this end, the Ministry conducts a biennial workshop to investigate the variability in the identification and evaluation of distresses (DMI), provide the Regions with the feedback and thereby improve the consistency of the province-wide rating of pavement performance.</p> <p>Based on the study of the survey results gathered in the 2007 Workshop, it is concluded that no significant variations exist in terms of ratings between regions. However there are province-wide variations in the assessment of a few distresses. In order to improve the accuracy and consistency of province-wide rating, the Ministry has established training circuits in each of its five Regions. Using these circuits, the staff should be periodically evaluated and their skills fine-tuned to ensure the continued accuracy and consistency in the evaluation of pavement distresses across the province.</p>
<b>Key Words</b>	COV (Coefficient of Variation), DMI (Distress Manifestation Index), IRI (International Roughness Index), PCI (Pavement Condition Index), PCR (Pavement Condition Rating), RCI (Ride Condition Index), RCR (Ride Condition Rating)
<b>Distribution</b>	Unrestricted technical audience.

Ministry of Transportation  
Materials Engineering and Research Report

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## Executive Summary

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A workshop was conducted to test raters in the evaluation of pavement surface distresses. As part of ensuring province-wide uniformity in pavement evaluation, twenty-one raters were tested against a Panel of five expert raters. The consistency in assessment of the severity and extent of pavement distresses was evaluated by comparing individual and regional ratings to a consensus rating made by the Panel. Six hot mix asphalt and two surface-treated pavement sections were selected. Drawn from the five Regional offices of the Ministry, the raters had varied experience in pavement evaluation.

Based on the study of the survey results gathered in the 2007 Workshop, it is concluded that no significant variations exist in terms of ratings between regions. However there are province-wide variations in the assessment of a few distresses. In order to improve the accuracy and consistency of province-wide rating, raters should be trained and tested in an environment where exchange of ideas in distress evaluation can take place, and individual biases can be readily identified and rectified. To this end, the Ministry has established training circuits in each of its five Regions. Using these circuits, the staff should be periodically evaluated and their skills fine-tuned to ensure the continued accuracy and consistency in the evaluation of pavement distresses across the province.





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# 1. Introduction

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Pavement condition evaluation is an essential component of all pavement management systems. Pavement evaluation, in turn, invariably includes the assessment of the ride quality (roughness), and the pavement distress manifestations as basic elements, although other elements such as structural adequacy and rut depth may also be incorporated. Pavement evaluation is used to assess the current condition of the pavement and to plan future rehabilitation measures, identifying when and where they will be required. Pavement distress manifestation is used to determine the causes of pavement deterioration and to select the most appropriate remedial treatment to restore pavement serviceability.

In quantitative terms, pavement condition is generally expressed as a Pavement Condition Index (PCI) or one of the several similar indices. These composite indices are derived from their constituent elements. The contribution of individual elements to the overall index depends upon the weightings assigned to each distress in the equation for calculating the composite index.

While the ride quality, structural strength, and rut-depth can be determined accurately and objectively using automated or mechanical methods, the most common method to evaluate distresses is through the visual inspection of the pavement. Although the systems are being developed to carry out distress surveys using video imaging or other scan-type techniques, they are not yet widely accepted for various reasons.

The visual inspection method, being subjective, is prone to personal bias and inadequate consistency and repeatability; these issues can be reduced by adopting standardized procedures and through appropriate training. If a number of raters are asked to evaluate a pavement, their evaluations are very likely to manifest variations that could be attributed to many factors, such as the training each rater received, the rater's experience, exposure to various types of distresses, the rater's perceptiveness at the time, personal bias etc.

The Pavements and Foundations Section has been conducting the biennial Pavement Condition Rating (PCR) workshop for nearly twenty years. The objective of the workshop is essentially to minimise the aforementioned variations through 1) training the relatively new raters in the Ministry's practice of pavement condition evaluation and 2) assessing, updating and enhancing the skills of the other raters. The workshop seeks to promote and ensure uniform pavement evaluation practices across the province. This year the workshop was held on June 12-14, in the vicinity of Orillia. This report provides the general details regarding the 2007 Workshop and the detailed analysis of the data collected during the workshop.



## 2. General Details

### 2.1 SELECTION OF SITES

The first task of the workshop was the selection of survey sites, which was accomplished with the assistance from the Geotechnical staff of Central Region. A search of the Ministry's pavement management system database indicated a number of sites in the vicinity of Orillia. After a visit to these sites, a total of eight pavement sections (six asphalt-concrete and two surface-treated) were selected for the survey circuit.

Each section is about 2 km in length, beginning and ending at unmistakably identifiable features such as side road junction and the conspicuous painted markings at both ends of each section. The sections range from relatively new pavements with few distresses to ones in fairly advanced stages of deterioration.

**Table 1 – 2007 PCR Workshop Survey Sections**

Sec #	Pav	Hwy	Dir	Location		Length (km)
				From	To	
1	AC	Hwy 12	W	Traffic Lights at Oro Medonte Line 15 / Wainman Line	Digby Rd (West Entrance)	1.9
2	AC	Hwy 12	W	Medonte Rd 2	Moonstone Rd 19 / Stage Coach Rd	1.9
3	AC	Hwy 12	W	Rosemount Rd / Duffy Drive	Granny White Side Road / Caswell's Rd	2.3
4	AC	Hwy 12	W	Beamish Rd (OPP Sign)	0.2km east of Hwy 93	1.4
5	AC	Hwy 93	S	Moonstone Rd 19 / South Orr Lake Rd	Flos Rd Seven East	1.7
6	AC	Hwy 11	N	Oro-Medonte Line 7 Overhead Structure	Oro-Medonte Line 9 Overhead Structure	2.4
7	ST	Mertz's Corner Rd	W	Hwy 93	Marshal Rd	1.7
8	ST	Flos Road Four East	W	Hwy 93	Old Second Rd North	2.1

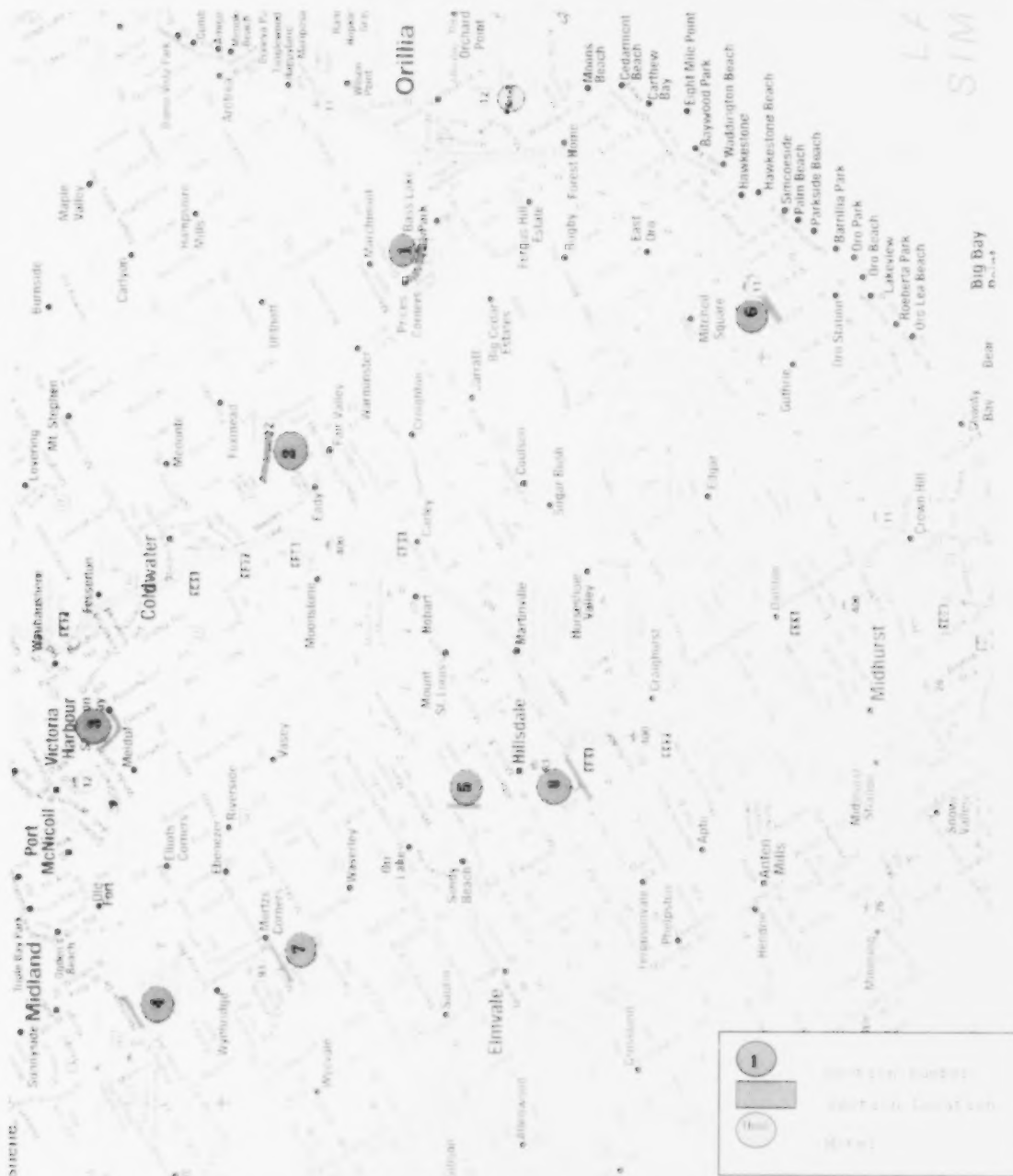


Figure 1 – Map of the PCR Circuit

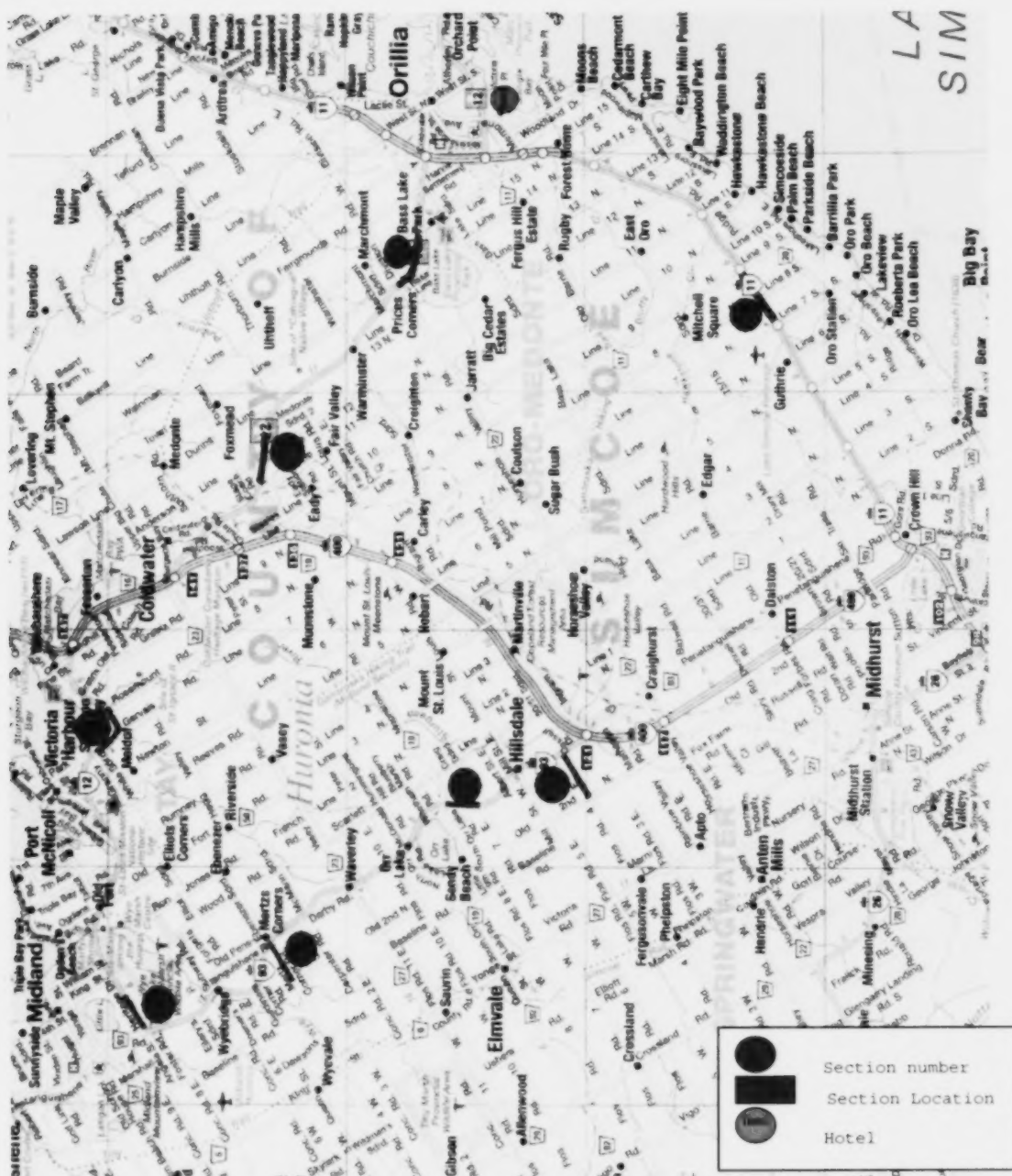


Figure 1 – Map of the PCR Circuit

## 2.2 METHODOLOGY

Forty-five participants belonging to all of the five Regions, MERO, and I&IT cluster, who are directly or indirectly involved in pavement condition evaluation, attended the workshop. Of the 45 participants, 21 were Regional raters with varying experience, who are responsible for regular pavement evaluation in their respective Regions. The number of raters from each Region ranged from three to six. The pavement raters had varying backgrounds: some had received on-the-job training from different senior Regional staff; some had many years' experience, while the others had little experience; some were more exposed to the distresses that are predominant in their Regions while others were not.

On the field day of the workshop, the raters were combined in groups of two to three per car. However, the raters were instructed to perform the ratings independently. Starting at different sections and travelling by different routes in order to avoid crowding at any one site, the raters drove over each section and recorded the severity and extent of distresses along with the subjective assessments of the RCR (Ride Comfort Rating) and PCR (Pavement Condition Rating) applicable to each section. The data thus gathered was statistically analyzed to study the inter/intra-Regional variations in ratings, the experiential impact, and to identify the distresses that were perceived particularly difficult to rate.

## 2.3 EXPERT PANEL RATING

Expert Panel rating forms the basis of the analysis carried out in this report. It is the benchmark rating with respect to which the variations in individual ratings are determined. The expert Panel consisted of the raters as identified by Regions. The expert Panel rating in this workshop was based on the consensus rating arrived at by the expert Panel after they had individually rated the survey sections and held extensive on-site discussions, several days ahead of the workshop. The finalized benchmark ratings are as follows:

**Table 2 – Panel's Consensus Ratings**

Sec #	RCR	PCR	DMI	IRI*	RCI*	PCI
1	9.0	90	9.58	1.00	8.50	92.5
2	5.5	53	6.97	3.56	4.72	49.8
3	7.5	72	7.99	1.43	7.42	74.9
4	6.0	60	7.24	2.33	5.95	61.4
5	8.6	87	8.67	1.01	8.47	84.2
6	7.5	72	8.06	1.17	8.03	77.5
7	8.2	82	8.07	1.62	8.27	76.5
8	6.8	65	6.15	2.44	6.85	54.7

*\*Denotes ARAN-based Measurements*

## 2007 WORKSHOP HIGHLIGHTS

- The workshop was held in Orillia, June 12-14, 2007
- Eight pavement sections were selected in the Orillia area for evaluation – Six Asphalt Concrete (AC) and two Surface Treatment (ST) sections
- Forty-five participants from MERO, ISB, the five Regions, and I&IT cluster attended the workshop
- Twenty-one Regional raters who perform pavement evaluation regularly were considered for the analysis
- Five expert Panel members from Regions evaluated the pavement sections prior to the workshop. They discussed amongst themselves to come up with a consensus rating to be used as the benchmark
- RCI values of all sections to be surveyed are based on IRI values which were obtained using MTO's ARAN

**Table 3 – List of 2007 PCR Workshop Regional Raters**

Region/Office	Raters	Region/Office	Raters
<b>Central Region (4)</b>	Fouad Tannous	<b>Northeastern Region (4)</b>	Fraser Strachan
	Ken Zasitko		Jason Wright
	Selva Reginold		Lynda Boyd
	Seyed Tabib		Marc Rockburn
<b>Eastern Region (6)</b>	Bruce Purchase	<b>Northwestern Region (3)</b>	Gary Dorval
	Chris Belanger		Al Brown
	Darren Waters		Armin DelRosario
	Stephanie Roller	<b>Southwestern Region (4)</b>	Nick Gilbert
	Ted Phillips		Ron Meertens
	Todd Filson		Robert Mount
			Scott Reid



### 3. 2007 Workshop Data Analysis

Survey results belonging to all of the twenty-one Regional raters were selected to perform the following analyses:

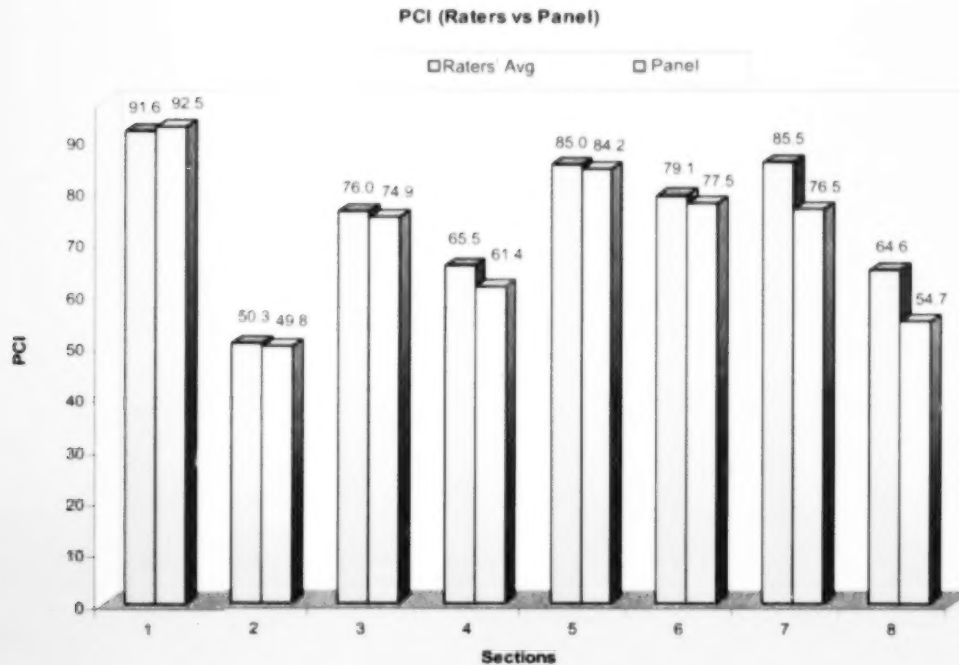
- Comparison of Province-Wide Ratings Vs. Panel Ratings
- Province-wide Variations Between Raters and Expert Panel
- Inter-Regional Comparisons
- Regional Variations
- Province-wide Variations in Individual Distress Rating

Variability is measured in terms of Reliability and Accuracy as described below.

- **Reliability:**
  - Mean value of all ratings is close to the Panel rating. However, the raters may or may not agree with each other in terms of their ratings.
  - Criterion: Survey data is considered reliable if  $|t \text{ statistic}| < t_{0.05} \text{ critical value}$  in the t-test.
- **Accuracy:**
  - Raters agree with each other in terms of their ratings. However, the mean value of their ratings may or may not agree with the Panel's rating.
  - Criterion: Survey data is considered accurate (variations are not significant) if  $COV \leq 0.1$

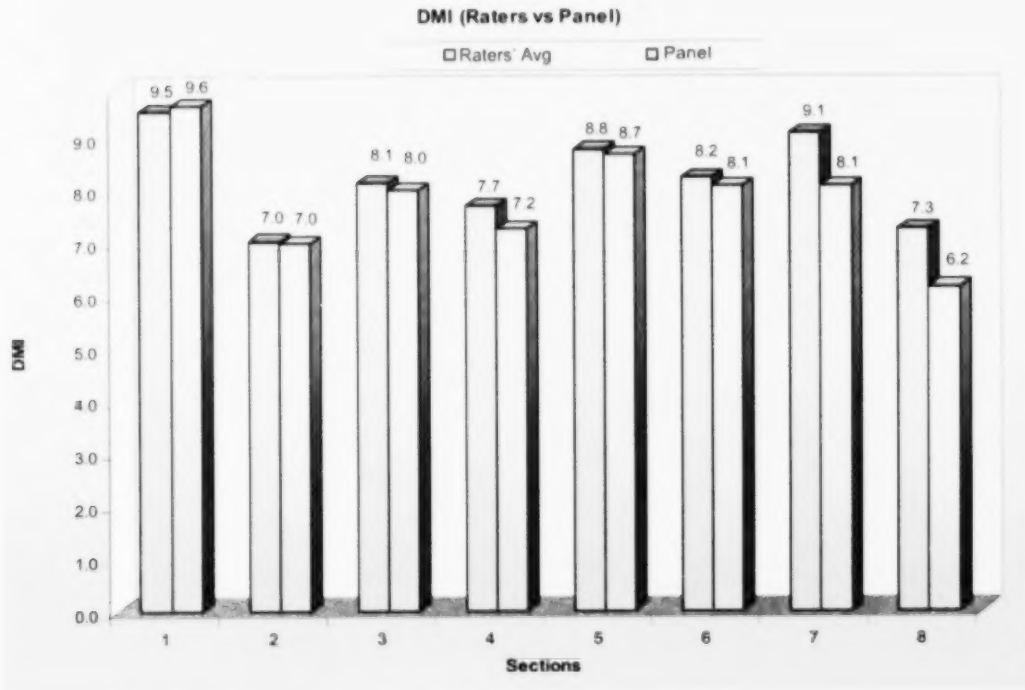


### 3.1 COMPARISON OF 2007 PROVINCE-WIDE RATINGS VS. EXPERT PANEL RATINGS (AVERAGE PCI)



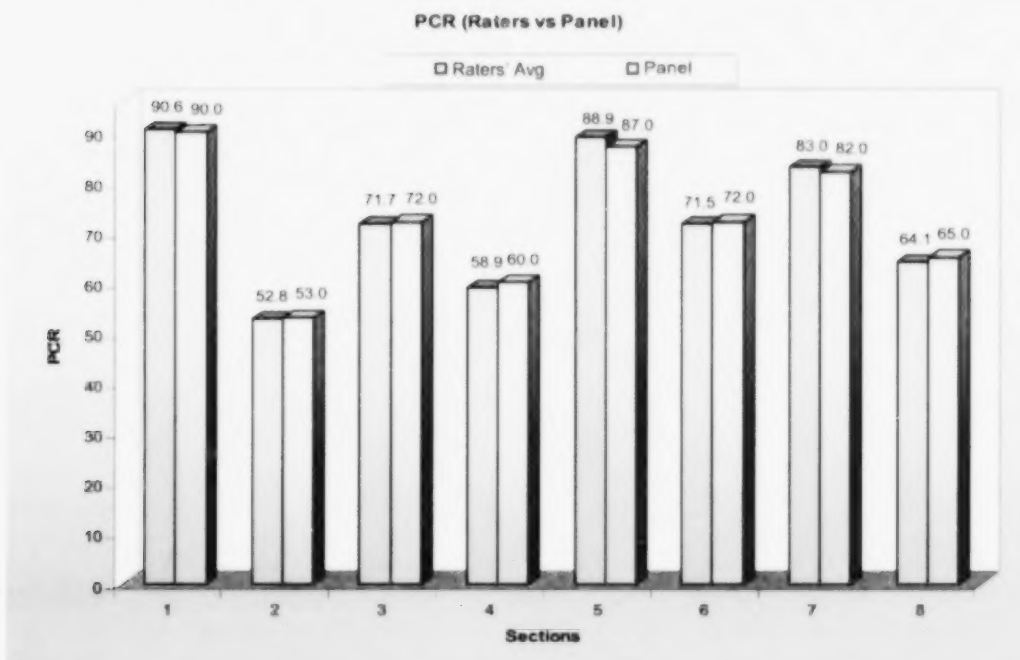
PCI Averages								
Section #	Pave Type	CR	ER	NE	NW	SW	Raters' Avg	Panel
1	AC	92.3	90.2	90.3	93.5	92.9	91.6	92.5
2	AC	41.6	49.6	51.6	54.7	55.1	50.3	49.8
3	AC	72.8	75.9	74.7	78.0	79.1	76.0	74.9
4	AC	60.9	67.8	66.1	68.4	63.9	65.5	61.4
5	AC	87.0	85.8	84.2	85.5	82.4	85.0	84.2
6	AC	78.4	79.5	77.7	82.3	78.1	79.1	77.5
7	ST	87.2	83.8	85.1	85.0	86.9	85.5	76.5
8	ST	71.0	61.7	66.0	62.2	62.9	64.6	54.7

### 3.2 COMPARISON OF 2007 PROVINCE-WIDE RATINGS VS. EXPERT PANEL RATINGS (AVERAGE DMI)



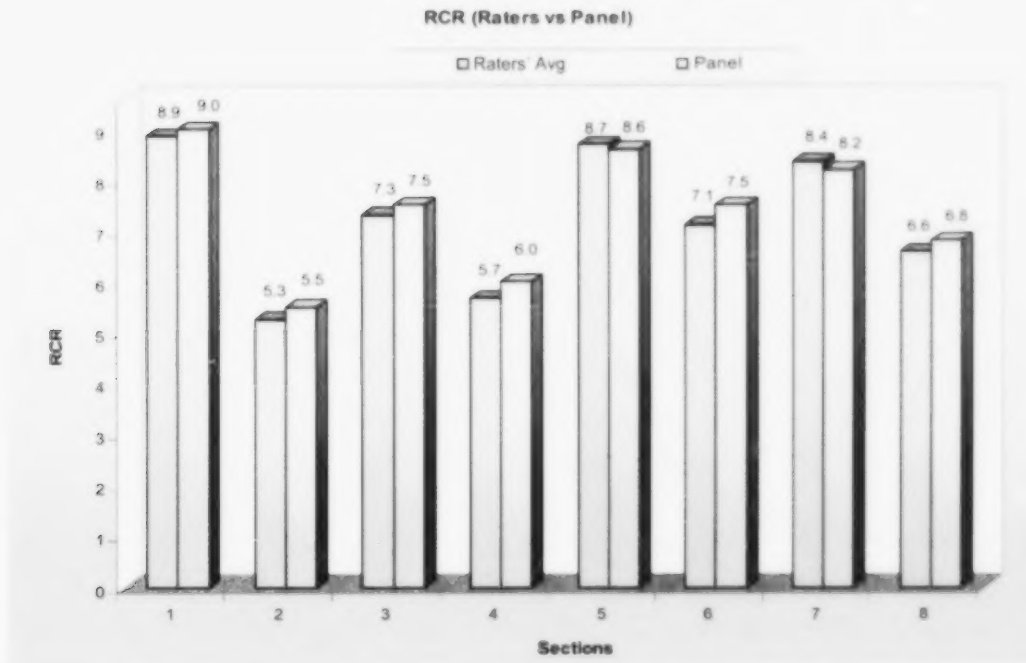
DMI Averages								
Section #	Pave Type	CR	ER	NE	NW	SW	Raters' Avg	Panel
1	AC	9.56	9.33	9.33	9.69	9.63	9.48	9.58
2	AC	6.06	6.95	7.17	7.52	7.56	7.02	6.97
3	AC	7.75	8.10	7.96	8.33	8.45	8.11	7.99
4	AC	7.18	7.94	7.76	8.01	7.51	7.69	7.24
5	AC	8.98	8.85	8.66	8.82	8.47	8.76	8.67
6	AC	8.16	8.29	8.08	8.59	8.12	8.23	8.06
7	ST	9.26	8.89	9.03	9.02	9.23	9.07	8.07
8	ST	7.96	6.92	7.41	6.99	7.06	7.25	6.15

### 3.3 COMPARISON OF 2007 PROVINCE-WIDE RATINGS VS. EXPERT PANEL RATINGS (AVERAGE PCR)



PCR Averages								
Section #	Pave Type	CR	ER	NE	NW	SW	Raters' Avg	Panel
1	AC	89.3	90.7	90.5	92.0	90.8	90.6	90.0
2	AC	50.5	55.3	55.5	50.3	50.3	52.8	53.0
3	AC	65.5	74.3	70.5	68.7	77.3	71.7	72.0
4	AC	53.5	61.5	60.8	58.3	59.0	58.9	60.0
5	AC	86.3	91.8	89.3	89.0	86.5	88.9	87.0
6	AC	67.0	73.2	70.0	75.0	72.5	71.5	72.0
7	ST	83.0	85.0	82.8	79.0	83.3	83.0	82.0
8	ST	67.3	61.7	63.5	64.3	64.8	64.1	65.0

### 3.4 COMPARISON OF 2007 PROVINCE-WIDE RATINGS VS. EXPERT PANEL RATINGS (AVERAGE RCR)



RCR Averages								
Section #	Pave Type	CR	ER	NE	NW	SW	Raters' Avg	Panel
1	AC	8.9	8.7	9.0	8.8	9.0	8.9	9.0
2	AC	5.6	5.2	5.5	4.9	5.1	5.3	5.5
3	AC	6.8	7.6	7.0	7.1	7.9	7.3	7.5
4	AC	5.4	5.7	5.7	5.6	5.9	5.7	6.0
5	AC	8.6	9.1	8.6	8.5	8.5	8.7	8.6
6	AC	6.7	7.2	7.0	7.5	7.3	7.1	7.5
7	ST	8.3	8.5	8.6	7.7	8.5	8.4	8.2
8	ST	6.8	6.4	6.8	6.3	6.6	6.6	6.8

### 3.5 PROVINCE-WIDE VARIATIONS BETWEEN RATERS AND EXPERT PANEL (AVERAGE PCI)

	Section #	1	2	3	4	5	6	7	8
	Pavement Type	AC	AC	AC	AC	AC	AC	ST	ST
A	Raters' Avg	91.6	50.2	76.0	65.5	85.0	79.1	85.5	64.6
B	Standard Dev.	2.46	7.04	2.92	4.61	3.04	2.89	4.06	6.77
C	COV	0.03	<b>0.14</b>	0.04	0.07	0.04	0.04	0.05	<b>0.10</b>
D	Panel PCI	92.5	49.8	74.9	61.4	84.2	77.5	76.5	54.7
E	Difference between Raters' Avg and Panel (A - D)	-0.9	0.4	1.1	4.1	0.8	1.6	<b>9.0</b>	<b>9.9</b>

#### Factors:

- t Statistic for Mean: 2.26;  $t_{0.05}$  Critical: 2.36 (2 tail); Average COV: 0.063

#### Conclusion:

- t Statistic (2.26) <  $t_{0.05}$  Critical (2.36) **PCI rating is reliable**
- *The PCI discrepancy between raters' average and Panel's consensus rating is greatest for ST pavements*
- Average COV (0.063) < 0.1 **PCI rating is accurate**

### 3.6 PROVINCE-WIDE VARIATIONS BETWEEN RATERS AND EXPERT PANEL (AVERAGE DMI)

	Section #	1	2	3	4	5	6	7	8
	Pavement Type	AC	AC	AC	AC	AC	AC	ST	ST
A	Raters' Avg	9.5	7.0	8.1	7.7	8.8	8.2	9.1	7.2
B	Standard Dev.	0.27	0.78	0.32	0.51	0.34	0.32	0.45	0.75
C	COV	0.03	<b>0.11</b>	0.04	0.07	0.04	0.04	0.05	<b>0.10</b>
D	Panel PCI	9.58	6.97	7.99	7.24	8.67	8.06	8.07	6.15
E	Difference between Raters' Avg and Panel (A - D)	-0.08	0.03	0.11	0.46	0.13	0.14	<b>1.03</b>	<b>1.05</b>

#### Factors:

- t Statistic for Mean: 2.25;  $t_{0.05}$  Critical: 2.36 (2 tail); Average COV: 0.060

#### Conclusion:

- t Statistic (2.25) <  $t_{0.05}$  Critical (2.36) **DMI rating is reliable**
- *The DMI discrepancy between raters' average and Panel's consensus rating is greatest for ST pavements*
- Average COV (0.060) < 0.1 **DMI rating is accurate**

### 3.7 PROVINCE-WIDE VARIATIONS BETWEEN RATERS AND EXPERT PANEL (AVERAGE PCR)

	Section #	1	2	3	4	5	6	7	8
	Pavement Type	AC	AC	AC	AC	AC	AC	ST	ST
A	Raters' Avg	90.6	52.8	71.7	58.9	88.9	71.5	83.0	64.0
B	Standard Dev.	2.01	4.03	5.17	4.81	3.14	4.71	4.46	4.73
C	COV	0.02	0.08	0.07	0.08	0.04	0.07	0.05	0.07
D	Panel PCI	90	53	72	60	87	72	82	65
E	Difference between Raters' Avg and Panel (A - D)	0.6	-0.2	-0.3	-1.1	1.9	-0.5	1.0	-1.0

**Factors:**

- t Statistic for Mean: 0.011;  $t_{0.05}$  Critical: 2.36 (2 tail); Average COV: 0.060

**Conclusion:**

- t Statistic (0.011) <  $t_{0.05}$  Critical (2.36)      **PCR rating is reliable**
- Average COV (0.060) < 0.1      **PCR rating is accurate**
- *PCR differences between raters' average and Panel's consensus rating are not significant*

### 3.8 PROVINCE-WIDE VARIATIONS BETWEEN RATERS AND EXPERT PANEL (AVERAGE RCR)

	Section #	1	2	3	4	5	6	7	8
	Pavement Type	AC	AC	AC	AC	AC	AC	ST	ST
A	Raters' Avg	8.9	5.3	7.3	5.7	8.7	7.1	8.4	6.6
B	Standard Dev.	0.34	0.56	0.55	0.59	0.40	0.52	0.47	0.74
C	COV	0.04	<b>0.11</b>	0.07	<b>0.10</b>	0.05	0.07	0.06	<b>0.11</b>
D	Panel PCI	9.0	5.5	7.5	6.0	8.6	7.5	8.2	6.8
E	Difference between Raters' Avg and Panel (A - D)	-0.1	-0.2	-0.2	-0.3	0.1	-0.4	0.2	-0.2

#### Factors:

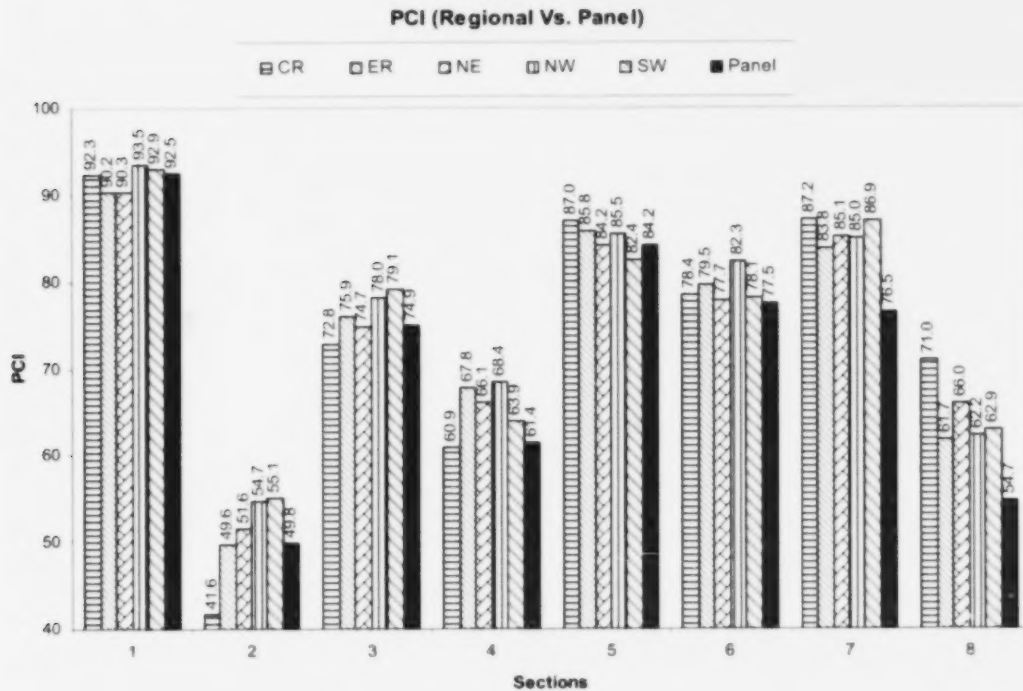
- t Statistic for Mean: -2.31;  $t_{0.05}$  Critical: 2.36 (2 tail); Average COV: 0.076

#### Conclusion:

- $|t \text{ Statistic}| (2.31) < t_{0.05} \text{ Critical } (2.36)$  **RCR rating is reliable**
- Average COV (0.076) < 0.1 **RCR rating is accurate**
- RCR differences between raters' average and Panel's consensus rating are not significant except for the Sections 2, 4 and 8*



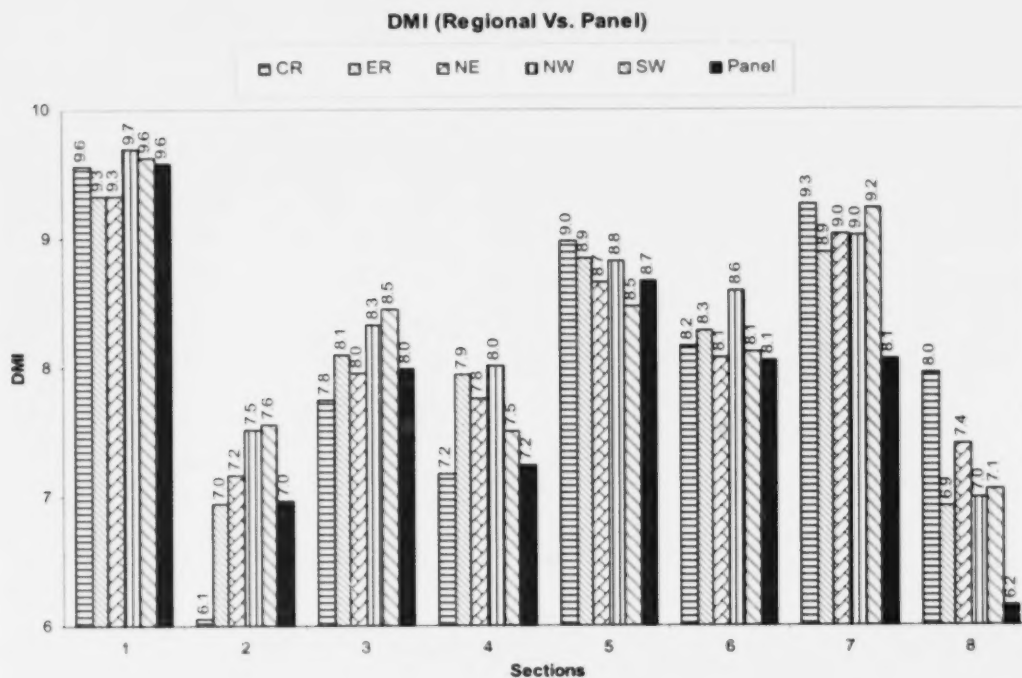
### 3.9 INTER-REGIONAL COMPARISONS (AVERAGE PCI)



Section Region	1 (AC)	2 (AC)	3 (AC)	4 (AC)	5 (AC)	6 (AC)	7 (ST)	8 (ST)
CR	92.3	41.6	72.8	60.9	87.0	78.4	87.2	71.0
ER	90.2	49.6	75.9	67.8	85.8	79.5	83.8	61.7
NE	90.3	51.6	74.7	66.1	84.2	77.7	85.1	66.0
NW	93.5	54.7	78.0	68.4	85.5	82.3	85.0	62.2
SW	92.9	55.1	79.1	63.9	82.4	78.1	86.9	62.9
Raters' Avg	91.6	50.3	76.0	65.5	85.0	79.1	85.5	64.6
<b>Panel</b>	<b>92.5</b>	<b>49.8</b>	<b>74.9</b>	<b>61.4</b>	<b>84.2</b>	<b>77.5</b>	<b>76.5</b>	<b>54.7</b>
Regional Mean	91.8	50.5	76.1	65.4	85.0	79.2	85.6	64.7
Std Dev.	1.34	4.90	2.27	2.74	1.56	1.67	1.27	3.47
<b>COV</b>	<b>0.01</b>	<b>0.10</b>	<b>0.03</b>	<b>0.04</b>	<b>0.02</b>	<b>0.02</b>	<b>0.01</b>	<b>0.05</b>

- Observation: PCI variability between Regions is not significant.

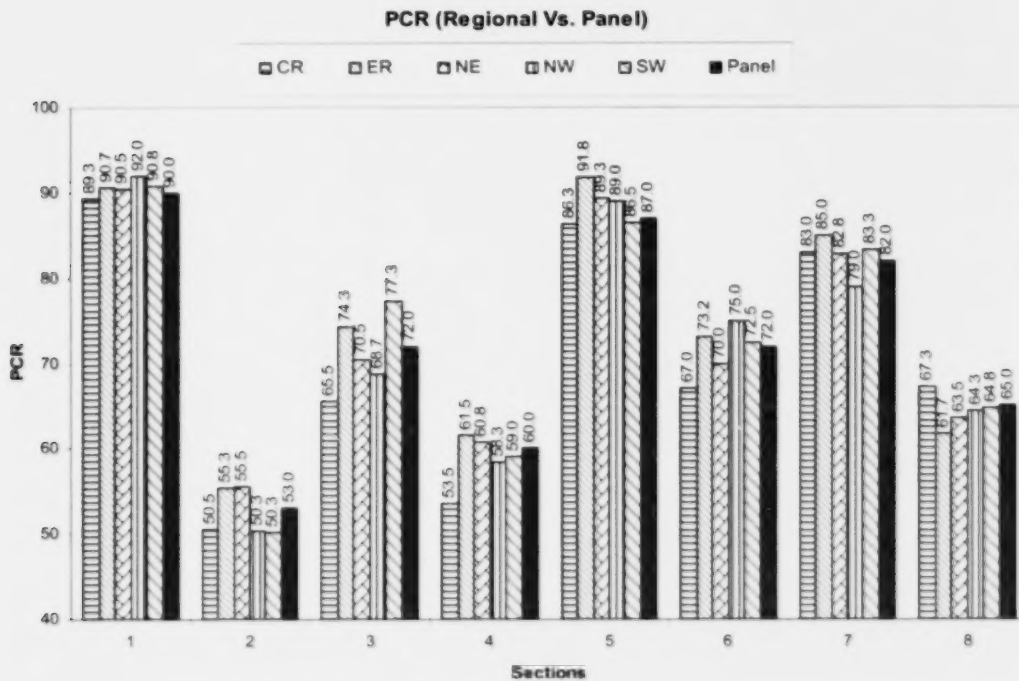
### 3.10 INTER-REGIONAL COMPARISONS (AVERAGE DMI)



Section Region	1 (AC)	2 (AC)	3 (AC)	4 (AC)	5 (AC)	6 (AC)	7 (ST)	8 (ST)
CR	9.6	6.1	7.8	7.2	9.0	8.2	9.3	8.0
ER	9.3	7.0	8.1	7.9	8.9	8.3	8.9	6.9
NE	9.3	7.2	8.0	7.8	8.7	8.1	9.0	7.4
NW	9.7	7.5	8.3	8.0	8.8	8.6	9.0	7.0
SW	9.6	7.6	8.5	7.5	8.5	8.1	9.2	7.1
Raters' Avg	9.5	7.0	8.1	7.7	8.8	8.2	9.1	7.3
<b>Panel</b>	<b>9.6</b>	<b>7.0</b>	<b>8.0</b>	<b>7.2</b>	<b>8.7</b>	<b>8.1</b>	<b>8.1</b>	<b>6.2</b>
Regional Mean	9.5	7.1	8.1	7.7	8.8	8.3	9.1	7.3
Std Dev.	0.15	0.55	0.25	0.30	0.18	0.18	0.14	0.38
<b>COV</b>	<b>0.02</b>	<b>0.08</b>	<b>0.03</b>	<b>0.04</b>	<b>0.02</b>	<b>0.02</b>	<b>0.02</b>	<b>0.05</b>

- *Observation: DMI variability between Regions is not significant*

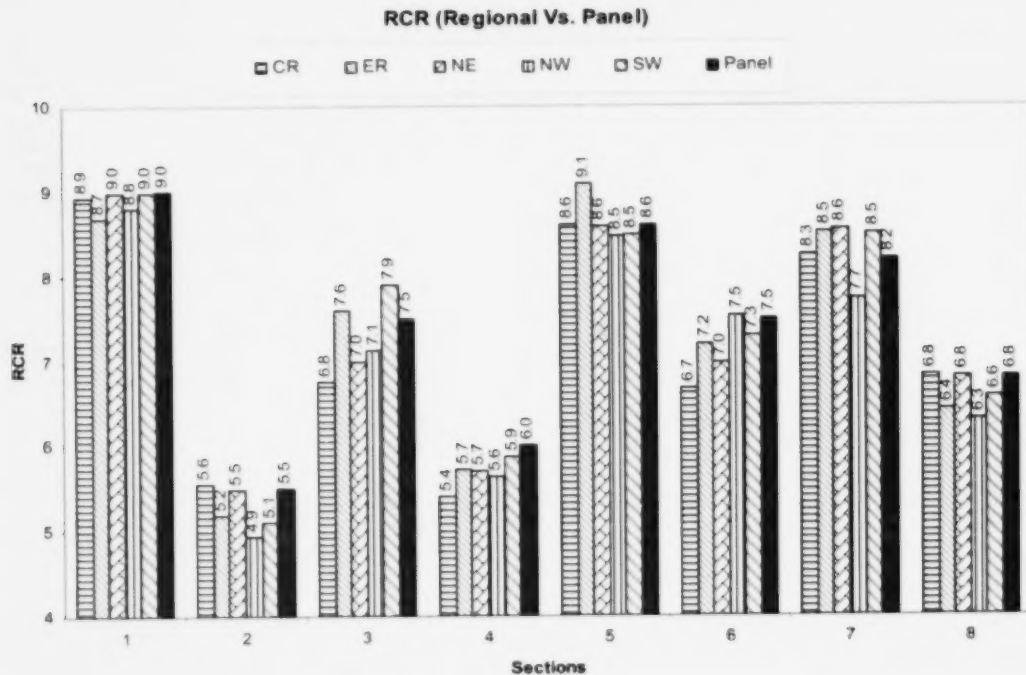
### 3.11 INTER-REGIONAL COMPARISONS (AVERAGE PCR)



Section Region	1 (AC)	2 (AC)	3 (AC)	4 (AC)	5 (AC)	6 (AC)	7 (ST)	8 (ST)
CR	89.3	50.5	65.5	53.5	86.3	67.0	83.0	67.3
ER	90.7	55.3	74.3	61.5	91.8	73.2	85.0	61.7
NE	90.5	55.5	70.5	60.8	89.3	70.0	82.8	63.5
NW	92.0	50.3	68.7	58.3	89.0	75.0	79.0	64.3
SW	90.8	50.3	77.3	59.0	86.5	72.5	83.3	64.8
Raters' Avg	90.6	52.8	71.7	58.9	88.9	71.5	83.0	64.1
<b>Panel</b>	<b>90.0</b>	<b>53.0</b>	<b>72.0</b>	<b>60.0</b>	<b>87.0</b>	<b>72.0</b>	<b>82.0</b>	<b>65.0</b>
Regional Mean	90.6	52.4	71.3	58.6	88.6	71.5	82.6	64.3
Std Dev.	0.87	2.48	4.14	2.80	2.05	2.78	1.97	1.81
<b>COV</b>	<b>0.01</b>	<b>0.05</b>	<b>0.06</b>	<b>0.05</b>	<b>0.02</b>	<b>0.04</b>	<b>0.02</b>	<b>0.03</b>

- Observation: PCR variability between Regions is not significant

### 3.12 INTER-REGIONAL COMPARISONS (AVERAGE RCR)



Section Region	1 (AC)	2 (AC)	3 (AC)	4 (AC)	5 (AC)	6 (AC)	7 (ST)	8 (ST)
CR	8.9	5.6	6.8	5.4	8.6	6.7	8.3	6.8
ER	8.7	5.2	7.6	5.7	9.1	7.2	8.5	6.4
NE	9.0	5.5	7.0	5.7	8.6	7.0	8.6	6.8
NW	8.8	4.9	7.1	5.6	8.5	7.5	7.7	6.3
SW	9.0	5.1	7.9	5.9	8.5	7.3	8.5	6.6
Raters' Avg	9.0	5.3	7.3	5.7	8.7	7.1	8.4	6.6
<b>Panel</b>	<b>9.0</b>	<b>5.5</b>	<b>7.5</b>	<b>6.0</b>	<b>8.6</b>	<b>7.5</b>	<b>8.2</b>	<b>6.8</b>
Regional Mean	8.9	5.3	7.3	5.7	8.6	7.1	8.3	6.6
Std Dev.	0.12	0.23	0.42	0.16	0.23	0.29	0.31	0.21
<b>COV</b>	<b>0.01</b>	<b>0.04</b>	<b>0.06</b>	<b>0.03</b>	<b>0.03</b>	<b>0.04</b>	<b>0.04</b>	<b>0.03</b>

- Observation: RCR variability between Regions is not significant

### 3.13 REGIONAL VARIATIONS (PCI, DMI, PCR AND RCR)

<b>Region \ Avg COV *</b>	<b>PCI</b>	<b>DMI</b>	<b>PCR</b>	<b>RCR</b>
Central	0.043	0.039	0.032	0.038
Eastern	0.056	0.054	0.050	0.082
Northeastern	0.055	0.053	0.067	0.081
Northwestern	0.038	0.036	0.036	0.053
Southwestern	0.045	0.043	0.035	0.039

- *Observation: Regional variations (PCI, DMI, PCR and RCR) are not significant*
- Avg COV:
  - The average of the eight sections' COV's calculated from the Std dev. of each rating within each Region divided by the average of that rating within the Region
- Criterion:
  - The difference of index rating within the Region is not significant if  $COV \leq 0.1$ ;
  - The difference of index rating within the Region is significant if  $COV > 0.1$

### 3.14 PROVINCE-WIDE VARIATIONS IN INDIVIDUAL DISTRESS RATINGS

The Standard Deviation (Std Dev) is adapted to examine whether the variation between raters is significant when they rate the individual distress's severity and density.

- Criterion:
  - The variation is not significant, if Std Dev  $\leq$  1.0;
  - The variation is significant, if Std Dev  $>$  1.0

**Table 4 – Province-Wide Variations in Individual Distress Rating (AC Pavement)**

Distress Type	Std Dev		Variation Significant	
	Severity	Density	Severity	Density
Ravel/C.A. Loss	0.83	<b>1.44</b>		<b>Yes</b>
Flushing	0.40	0.45		
Rippling/shoving	0.11	0.33		
Wheel Track Rutting	0.57	<b>1.28</b>		<b>Yes</b>
Distortion	0.91	<b>1.04</b>		<b>Yes</b>
Longitudinal Cracking - Single/Multiple	0.70	0.83		
Longitudinal Cracking – Alligator	0.51	0.41		
Centreline Cracking - Single/Multiple	0.64	0.91		
Centreline Cracking– Alligator	0.18	0.11		
Pavement Edge Cracking – Single/Multiple	0.96	0.94		
Pavement Edge Cracking – Alligator	0.42	0.40		
Transverse Cracking – HFM	0.45	0.69		
Transverse Cracking Alligator	0.54	0.41		
Longitudinal Cracking Meandering Midline	0.66	0.65		
Random Cracking	0.62	0.81		

- *Observation: Variations are significant for a few AC distresses (Densities), particularly for Ravelling, Wheel Track Rutting and Distortion.*

**Table 5 ~ Province-Wide Variations in Individual Distress Rating  
(ST Pavement)**

Distress Type	Std Dev		Variation Significant	
	Severity	Density	Severity	Density
Loss of coarse aggregates	0.97	<b>1.29</b>		<b>Yes</b>
Streaking	0.85	<b>1.29</b>		<b>Yes</b>
Flushing	0.52	0.59		
Pothole	0.59	0.50		
Pavement Edge Breaking	0.81	0.93		
Rippling	0.39	0.50		
Wheel Track Rutting	0.97	<b>1.23</b>		<b>Yes</b>
Distortion	0.87	<b>1.03</b>		<b>Yes</b>
Longitudinal Cracking	0.83	0.83		
Transverse Cracking	0.56	0.56		
Pavement Edge Cracking	0.83	0.74		
Alligator Cracking	0.73	0.80		

- *Observation: Variations are significant for a few ST distresses (Densities), particularly for Loss of coarse aggregates, Streaking, Wheel Track Rutting and Distortion.*



## 4. Summary and Conclusions

As part of ensuring province-wide uniformity in pavement evaluation, twenty-one raters were tested against a Panel of five expert raters. The consistency in assessment of the severity and extent of pavement distresses was evaluated by comparing individual and regional ratings to a consensus rating made by the Panel. Six hot-mix asphalt and two surface-treated pavement sections were selected. Drawn from the five Regional offices of the Ministry, the raters had varied experience in pavement evaluation.

The following conclusions have been made from the comparison:

- By and large, the raters are consistent in their assessment of PCR, RCR and distresses of asphaltic pavements, which represent 76% of the provincial highways network.
- There are some inconsistencies when evaluating surface treated pavements, which represent 18% of the network (see Sections 3.5 and 3.6.)
- Province-wide RCR differences between raters' average and Panel's rating (see Section 3.8) are not significant except for the Sections 2, 4, and 8.
- Section 2 manifests large variations between raters as to the assessment of PCI, DMI and RCR, indicated by the COV exceeding 0.1 for these indices.
- Inter-Regional ratings are consistent for all four indices (PCI, DMI, PCR, RCR) for all raters.
- A few distresses in AC and ST pavement types show significant province-wide variations. In particular, the consistencies of density for Coarse Aggregate Loss, Wheel Track Rutting and Distortion need to be improved amongst all raters.

The workshops are very well received and undoubtedly conducive to ensuring province-wide consistency in evaluating pavements. In order to improve the accuracy and consistency of province-wide rating, raters should be trained and tested in an environment where exchange of ideas in distress evaluation can take place, and individual biases can be readily identified and rectified. To this end, the Ministry has established training circuits in each of its five Regions. Using these circuits, the staff should be periodically evaluated and their skills fine-tuned to ensure the continued accuracy and consistency in the evaluation of pavement distresses across the province.





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# Glossary of Keywords

**COV** (Coefficient of Variation): Sometimes denoted *cv*, it is the standard deviation divided by the mean of a sample set. COV is a statistical measure to quantify normalized variance, or spread, in a set of measurements. Commonly, the variation is deemed not significant when COV is less than or equal to 0.1. (For example the following set of numbers has a COV of 0.1: {8.5, 9.5, 10.5, 11.5})

**DMI** (Distress Manifestation Index): Based on a scale of 0-10 (extremely distressed to distress-free), this index represents the aggregate effect of various distresses manifested over a given pavement surface. It is purely subjective as it is only based on rater's ability to identify a distress and quantify it in terms of its severity and extent.

**IRI** (International Roughness Index): Based on a scale of 0 to infinity (perfectly smooth to infinitely rough), it is an international standard for measuring pavement roughness based on a quarter-car model and a standard sprung mass.

**PCI** (Pavement Condition Index): Based on a scale of 0-100 (failed to perfect pavement), PCI is MTO's overall measurement of pavement condition. It is obtained by combining the DMI (subjective) and RCI (objective) values in a linear model. PCI is a more objective version of PCR.

**PCR** (Pavement Condition Rating): On a scale of 0-100 (failed to perfect pavement), it is based on the rater's perception of the combined effects of RCR and DMI.

**RCI** (Ride Condition Index): On a scale of 0-10 (very poor- excellent), RCI is similar to RCR except it is objectively obtained. Specialized equipment is driven over the pavement section to gather data and obtain a rating. From 1985 to 1996, MTO used the PURD (Portable Universal Roughness Device, a trailer-mounted response-type measuring device) to measure RCI values. However, as of 1997 MTO has switched to the measurement of IRI values, which are based on the actual pavement profile of the roadway. RCI values are derived from IRI measurements using an exponential regression model. MTO's ARAN was used to obtain IRI/RCI values of all of the sections surveyed during the workshop.

**RCR** (Ride Condition Rating): On a scale of 0-10 (very poor to excellent), it is the subjective assessment of pavement ride condition and mainly depends on the perception of the rater.

